PERFORMANCE OF FLAMELESS COMBUSTION USING PALM OIL MILL EFFLUENT BIOGAS

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All praises is due to God, Who has taught man what he did not know.

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ABSTRAK

Biogas yang dihasilkan daripada effluen kilang minyak sawit (POME) adalah sejenis sumber tenaga boleh diperbaharui yang boleh didapati dengan banyaknya di Malaysia daripada industri minyak sawit yang besar. Walau bagaimanapun, disebabkan nilai kalorinya yang rendah, potensi penuh POME biogas masih tidak diterokai sepenuhnya. Pembakaran tanpa api *(flameless)* merupakan kaedah pembakaran baru yang mempunyai kelebihan daripada segi penghasilan gas pencemar oksida nitorgen (NOx) yang rendah. Pembakaran tanpa api juga dipercayai dapat menerima bahan bakar berkalori rendah tanpa sebarang masalah. Dalam kajian ini, pembakaran tanpa api menggunakan POME biogas telah dikaji dan prestasinya dianalisis dan dibandingkan dengan pembakaran tanpa api menggunakan gas asli. Satu sistem pemampatan biogas dan sistem penyimpanan telah direka dan diuji untuk dibekalkan kepada sistem pembakaran tanpa api. Hasil kajian menunjukkan bahawa pembakaran tanpa api berjaya dicapai menggunakan tiga jenis bahan api iaitu gas asli, biogas tiruan (75% gas asli, 25% CO2) dan biogas POME. Suhu purata relau ketika pembakaran tanpa api POME biogas didapati mempunyai suhu purata lebih rendah (2.69% pengurangan) disebabkan oleh peningkatan gas lengai di dalam ruang relau. Pembakaran tanpa api menghasilkan kawasan pembakaran yang lebih besar dan lebih seragam (R_{TU} = 0.097) berbanding dengan pembakaran api konvensional (R_{TU} = 0.21). Ukuran pelepasan NOx telah menunjukkan pengurangan pelepasan NOx dalam pembakaran tanpa api menggunakan gas asli, biogas POME dan biogas simulasi. Magnitud pelepasan NOx dalam pembakaran tanpa api adalah 6 ppm purata bagi ketiga-tiga jenis bahan api. Nisbah setara campuran pembakaran mempunyai sedikit kesan terhadap pembentukan NOx.

ABSTRACT

Biogas produced from palm oil mill effluent (POME) is a type of renewable energy source that is available in abundance in Malaysia from its large palm oil industry. However, due to its low calorific value, POME biogas full potential has not been fully explored. Flameless combustion is new low NOx combustion method which is believed to be able to accept low calorific fuels easily. In this study, POME biogas has been used to fuel a flameless combustor and its performance was analyzed in comparison to flameless combustion of natural gas. A biogas compression and storage system was designed and tested to fuel the flameless combustion system. Results show that mild flameless combustion regime is achieved for natural gas, simulated biogas (75% natural gas, 25% CO_2) and POME biogas. POME biogas flameless combustion has slightly lower average furnace temperature (2.69% reduction) due to increased inert gas in the furnace chamber. Flameless combustion produce a larger and more uniform combustion area (R_{tu} = 0.097) compared to conventional flame combustion (R_{tu} = 0.21). NOx emission measurement has shown reduced NOx emission in flameless combustion of natural gas, POME biogas and simulated biogas. The magnitude of NOx emission in flameless combustion is 6 ppm in average for the three fuel type. Equivalence ratio of combustion mix has little effect of NOx formation.